

Appl. No. : 09/801,542
Filed : March 7, 2001

REMARKS

In response to the Office Action mailed November 14, 2002, Applicant respectfully requests the Examiner to reconsider the above-captioned application in view of the above amendments and the following comments.

Matters of Form

The Specification and Claim 50 have been amended to correct the informalities noted by the Examiner.

Claims 31-43

Claims 31 and 43 are rejected under 35 U.S.C. 102(e) as being anticipated by Kim et al. (U.S. Patent No. 6,306,216). Claims 32-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. Claims 34-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over of Kim et al. in view of Suntola et al. (U.S. Patent No. 6,015,590) and Yokoyama et al. (U.S. Patent No. 4,897,709). Claims 34-36 and 39-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. in view of Eichman et al (U.S. Patent No. 5,348,587).

Applicants respectfully traverse the rejections of Claims 31-43. Nevertheless, to advance prosecution, Applicants have canceled Claims 31-34 and 36 and have amended Claims 37-43 such that they now depend upon Claim 35, which has been rewritten into independent form. The rejections of Claims 31-34 and 36-35 are therefore moot. The rejection of original Claim 35 will be addressed below.

Claim 35 recites, in part, a method for growing a thin film on a substrate "wherein the substrate support temperature is maintained at a first temperature and the chamber wall temperature is maintained at a second temperature different from the substrate support temperature and wherein a difference between the first temperature and the second temperature is selected to maintain a lower rate of film growth upon the chamber walls as compared to the substrate." In one of the disclosed embodiments, a lower rate of film growth is maintained by keeping the temperature of the chamber wall above or below the ALD temperature window (W). See the Specification at page 4, line 29 and Figure 1. For certain combinations of reactants, a

temperature below the ALD window (W) produces decreased growth per cycle (L2). However, there is a lower limit to this decreased growth region (L2) at which increased deposition eventually occurs because of condensation. In a similar manner, for certain combinations of reactants, a temperature above the ALD window produces decreased growth per cycle (H2). However, there is an upper limit to this decreased growth region (H2) at which increased deposition eventually occurs because of thermal decomposition. As such, the upper and lower windows (L2, H2) of decreased growth have upper and lower temperature limits.

In rejecting Claim 35, the Examiner uses Kim et al. as the primary reference. Kim et al. discloses a reaction chamber 700 that has a wafer heating unit 702 and a reaction chamber heating unit 705. Col. 8, lines 23-30. The reaction chamber heating unit 705 makes it "possible to keep the temperature of the reaction chamber 700 at an appropriate temperature suitable for performing a desired thin film vapor deposition process." Col. 9, lines 61-65. Kim et al. does not disclose selecting a difference between the chamber wall temperature and the substrate support temperature so as to "maintain a lower rate of film growth upon the chamber walls as compared to the substrate." To cure this deficiency, the Examiner cites Suntola et al. In turn, Suntola et al. discloses that "hot wall reactors" as applied to an ALE process can provide improved material utilization by revaporizing atoms or molecules that impinge on the wall. Col. 2, lines 45-55. The Examiner cites Yokoyama et al. for the proposition that "hot wall" means that the temperature of the reaction chamber is higher than that of the substrate. Col. 2, lines 64-67.

Even assuming there is motivation to combine the references as suggested by the Examiner, Applicants respectfully submit that the Examiner has not established a *prima facie* case of obviousness because the cited references do not disclose a method of growing a thin film wherein the temperature of the chamber walls is selected "to maintain a lower rate of film growth upon the chamber walls as compared to the substrate." In contrast, the cited combination at best simply discloses maintaining the reaction chamber at a temperature above the substrate temperature. However, as explained above, maintaining the reaction chamber at a temperature above the substrate may result in increased deposition when thermal decomposition causes deposition. Neither Suntola et al. nor any other reference of record teaches or suggests selection

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of the wall temperatures as recited in the claims. For at least this reason, Applicants respectfully submit that Claim 35 is allowable over the combination of Kim et al., Suntola et al. and Yokoyama et al.

Claim 35 stands rejected as unpatentable over Kim et al. in view of Eichman et al. As mentioned above, Kim et al. does not disclose selecting the difference between the chamber wall temperature and the substrate support temperature so as to “maintain a lower rate of film growth upon the chamber walls as compared to the substrate.” To address this deficiency, the Examiner cites Eichman et al. as teaching “elevating (i.e., heating) the surface of the wafer to a reaction temperature while maintaining other parts of the reactor (e.g., chamber walls) at a lower temperature, which prevents the deposition of coating material on surfaces other than on the surface of the substrate to be coated.” However, with reference to Col. 1, lines 25-34, Eichman disclosed a CVD reactor in which the temperature of “other parts of the reactor [are maintained] at lower, near ambient temperature” to “prevent the occurrence of the reaction and the deposition of the coating material other than of on the surface of the substrate to be coated.” As explained in the specification at page 2, lines 25-31, applying a conventional CVD reactor cold wall design to an ALD reactor is particularly harmful because it can cause increased adsorption or even condensation of the reactants on the wall. While Eichman et al. may teach lowering CVD reaction rates on cold wall chambers, Eichman et al. does not teach controlling the temperatures to reduce ALD reaction rates on the chamber walls, and Claim 35 specifically recites “alternately and sequentially feeding at least two vapor phase reactants into the reaction chamber.” Thus, the applied combination would not result in “a lower rate of film growth upon the chamber walls as compared to the substrate” for ALD reactions. Accordingly, Applicants respectfully submit that the rejection of Claim 35 of the combination Kim et al. in view of Eichman et al. is improper.

For at least the reasons set forth above, Applicants submit that Claim 35 is in condition for allowance. As amended Claims 37-42 depend upon allowable Claim 35. These claims are also in condition for allowance because, *inter alia*, they depend upon allowable Claim 35.

Claims 44-49

Claims 44, 45 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over of Kim et al. in view of Suntola et al. and Yokoyama et al. Claims 46 and 47 are rejected under 35

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U.S.C. 103(a) as being unpatentable over Kim et al. in view of Suntola et al. and Yokoyama et al., and in further view of Tseng (U.S. Patent No. 4,897,709). Claims 44, 48 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. in view of Eichman et al.

Applicants respectfully traverse the rejections of Claims 44-49. Nevertheless, to advance prosecution, Applicants have canceled Claim 49 and added its limitations to independent Claim 44. As set forth above, Applicants respectfully submit that the cited combinations do not disclose a method for growing a thin film on a substrate by "alternately and sequentially feeding at least two vapor phase reactants into the reaction chamber" wherein the temperature of the chamber walls is maintained at a second temperature and "wherein the second temperature is selected to lower a rate of film growth upon the walls relative to the substrate." For at least this reason, Applicant submits that Claim 44, as amended, is in condition for allowance. Claims 45-48 claims are also in condition for allowance because, *inter alia*, they depend upon allowable Claim 44.

Claims 50-56

Claims 50-56 are rejected under 35 U.S.C. 102(e) as being unpatentable over of Kim et al. in view of Suntola et al. and Yokoyama et al. Claims 50-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. in view of Eichman et al.

Applicants respectfully traverse the rejection of Claims 50-56. Claim 50 recites, in part, a method for preventing unwanted deposition on walls of an ALD reaction chamber comprising controlling a temperature of a substrate and independently controlling a temperature of at least those portions of the chamber walls exposed to reactants, such that a rate of deposition by self-limited atomic layer deposition on the substrate is maximized while film growth on the walls is reduced relative to controlling a temperature of the substrate alone. Again as mentioned above, the cited combinations do not disclose controlling the temperature of the chamber walls to reduce deposition on the chamber walls. In addition, the cited combinations do not disclose controlling the temperature of the chamber walls to maximize film growth by ALD on the substrate while film growth on the walls is reduced relative to controlling a temperature on the substrate alone.

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New Claims

Applicants have added new Claim 57, which Applicants respectfully submit is also patentable over the cited art. Specifically, the cited art does not disclose a method for growing a thin film on a substrate comprising "maintaining the temperature of the substrate within an ALD temperature window such that approximately one monolayer is deposited per full cycle and maintaining the chamber wall temperature within a temperature window that is either (i) above a lower temperature limit at which condensation takes place on the chamber walls and below the ALD temperature window or (ii) below a high temperature limit at which thermal decomposition causes deposition on the chamber walls and above the ALD temperature window."

CONCLUSION

For the foregoing reasons, it is respectfully submitted that the rejections set forth in the outstanding Office Action are inapplicable to the present claims and specification. Accordingly, early issuance of a Notice of Allowance is most earnestly solicited.

The undersigned has made a good faith effort to respond to all of the rejections in the case and to place the claims in condition for immediate allowance. Nevertheless, if any undeveloped issues remain or if any issues require clarification, the Examiner is respectfully requested to call Applicant's attorney in order to resolve such issue promptly.

Respectfully submitted,

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